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HANDLING SPINACH FOR LONG-DISTANCE SHIPMENT



SPINACH has become an important winter crop in some of the southern truck-growing sections. Shipments amounting to 2,102 cars were made in 1919, of which approximately 87 per cent were from Texas and Virginia.

Careful handling must begin in the field. The spinach should be handled no more than is absolutely necessary, and each operation should be arranged to cause as little bruising and breaking of the leaves as possible. Slightly wilted spinach plants can be handled with less damage than crisp, turgid ones, but excessive wilting should be avoided.

Washing increases decay. It is recommended that spinach be shipped unwashed, unless it is very dirty. When it must be washed, care should be used.

Prompt and thorough cooling is necessary to secure the best conditions in transit. Crushed ice may be used to advantage in each package, and should be placed in two layers, part in the center and part on top of the spinach. All packages should be loaded right side up in the cars.

To secure the most efficient refrigeration from the ice in the bunkers of cars, space must be provided for air circulation above and below the load.

Contribution from Bureau of Markets

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HANDLING SPINACH FOR LONG-DISTANCE SHIPMENT.

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EXTENT OF COMMERCIAL CROP.

SPINACH has been an important winter and spring crop in the Norfolk section of Virginia for a number of years and heavy shipments are made by water and rail to northern markets. Within the last few years this industry has become established in Texas and southern California and has developed so rapidly that shipments from Texas now exceed those from Virginia. In 1919, car-lot shipments from Texas amounted to 954 cars, of which 522 were from the Austin district. The 1919 shipments from Virginia were equivalent to 874 cars. Southern California shipped about 190 cars. Plantings for the 1919-20 season were 6,350 acres in Texas, 3,750 acres in Virginia, and 1,350 acres in southern California. Spinach is also grown to a more limited extent in the New Orleans section of Louisiana, shipments from there being in mixed cars.

In the Louisiana and Texas sections plantings of spinach are made from early fall to midwinter in order to secure plants for harvesting during the months of January, February, March, and April. The most widely grown varieties are the Bloomsdale and Viroflay. The former has a crinkled leaf which is somewhat darker in color than the smooth-leaved Viroflay. Prickly Seeded, another smooth-leaved spinach and the hardiest variety, is grown to a limited extent, but it is discriminated against on the markets on account of its appearance.

METHODS OF HARVESTING.

Spinach may be harvested from the time the plants have five or six leaves until just before the time when they begin to form seed stems. A larger yield, of course, is secured if plants are not cut too early.

The market prefers medium or slightly larger plants, when the leaves are tender and in good condition and the stems are not too coarse. The best time to harvest depends upon market conditions. Two or more cuttings are usually made, the smaller plants being left at the first cutting.

Spinach should be harvested by cutting the tap root just below the lower leaves. A knife with a long blade like a butcher knife is usually used, although a hoe is sometimes employed. The method of harvesting with a knife is shown on the cover, while the use of the hoe for this purpose is illustrated in figure 1. If the tap root is cut short it is possible to avoid taking up a lump of dirt with the plant. Pulling is a practice to be condemned, because it breaks and bruises the tender leaves even when the ground is not hard.

Wages for cutting spinach are often paid at a fixed rate per basket or field box. When whole families, old and young alike, work



FIG. 1.—Harvesting spinach with hand hoes. Laredo, Tex., April, 1919.

in the field, this method has obvious advantages. As a rule more careful cutting is secured if the work is done only by adults.

Some trimming is usually necessary to remove all dead, diseased, or yellow lower leaves, and this can best be done as the plants are cut (fig. 2). These leaves detract greatly from the appearance of the plants and are very susceptible to decay.

It is best not to cut spinach immediately after a rain or a heavy dew, because when the leaves are damp they are crisp and brittle and break easily. When plants are grown under conditions of abundant moisture and cut in damp or cloudy weather it is well to let them lie on the ground one or two minutes, which is long enough to wilt the leaves slightly, before handling. Certain men may cut the spinach and others follow to do the stripping and gather it into the field baskets. Under most conditions plants are not so brittle as to require this preliminary wilting, and when it is permitted there is always danger of too much wilting.



FIG. 2.—Mexicans trimming spinach. Dead leaves and trash should be removed at the time of cutting, to avoid extra handling. Laredo, Tex., April, 1919.

After cutting and trimming, the plants are carried to the packing shed. Hauling in field baskets or boxes is better for the spinach than loading it in bulk, as less handling is involved. The latter method also requires the use of forks in unloading, which results in considerable mechanical damage to the plants, as is shown in figure 3.



FIG. 3.—Unloading spinach from truck at the packing shed. Hauling spinach in bulk causes a great amount of injury to the leaves and leads to decay in transit. Austin, Tex., March, 1919.

Spinach should be removed to the shed and packed as soon as possible after cutting, in order to avoid excessive wilting or heating.

PREPARATION FOR SHIPMENT.

In different sections of the country various packages are used, the round bushel basket, barrel, and lettuce crate being the favorites. In some instances, but not usually, the spinach for each crate is weighed in order to obtain a uniform pack. Facing is sometimes practiced to make the package more attractive.

WASHING.

When spinach is covered with sand or mud from the fields, it is usually washed to improve its appearance. Sometimes it is washed or moistened to restore freshness. It is better to avoid washing when possible, since the washing is likely to bruise the plants and increase decay. In washing, the plants are immersed in water in large tanks of wood, galvanized iron, or concrete, and allowed to remain at least two or three minutes. The plants should be stirred gently in the water to loosen as much dirt as possible. Fresh water should be kept running into the tank, and the wash water should be drained and the tanks cleaned at least once or twice each day. Although it is best to use cold water, it is doubtful whether the addition of ice is advantageous. This washing does not, of course, clean the plants thoroughly; this must be done by the housewife.

ICING.

In addition to the regular icing of the bunkers of the refrigerator car, some crushed ice is used in each package. The amount of crushed ice for each package varies somewhat under different conditions, the quantity ordinarily provided being from two-thirds to three-fourths of the weight of the spinach. In icing barrels, the ice is usually distributed in three or four layers. Some ice should be placed on top next to the barrel head to keep the spinach in the upper part of the barrel fresh. More ice should be used in the layer next to the top of the barrel than in the other layers and holes should be bored in the bottoms of the barrels to insure drainage.

Baskets are usually iced with one shovelful near the center of the basket, but the more desirable method is to place about half the ice in the center and the remainder on top.

LOADING CARS FOR SHIPMENT.

For shipments which may be in transit several days the use of floor racks is desirable. This provides open spaces under the load for air circulation from the ice bunkers of the cars, thus facilitating

thorough refrigeration throughout the car from the ice in the bunker. Otherwise this refrigeration is applied largely to the packages next to the bunkers, and does not reach those out toward the center of the car, which is usually the warmest part of the load. For the same

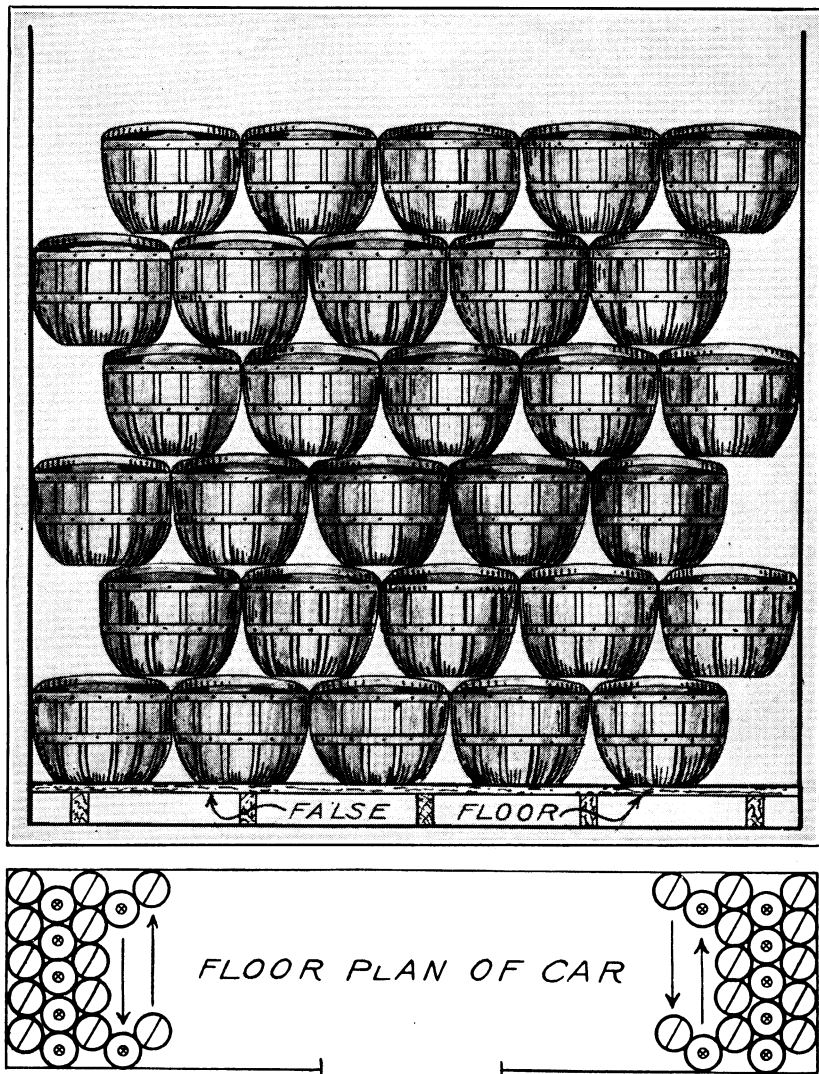


FIG. 4.—Method of loading bushel baskets. Alternate baskets reversed.

reason, also, it is unwise to block the air circulation back to the ice bunkers by loading close to the ceiling of the car. Figures 4 and 5 show cars of baskets loaded properly to provide for air circulation both above and below the load.

PREVENTION OF DETERIORATION IN TRANSIT.

The shipments from Virginia, because the haul is comparatively short, usually reach the market in sound condition without refrigeration. However, when shipments were begun from Texas and other

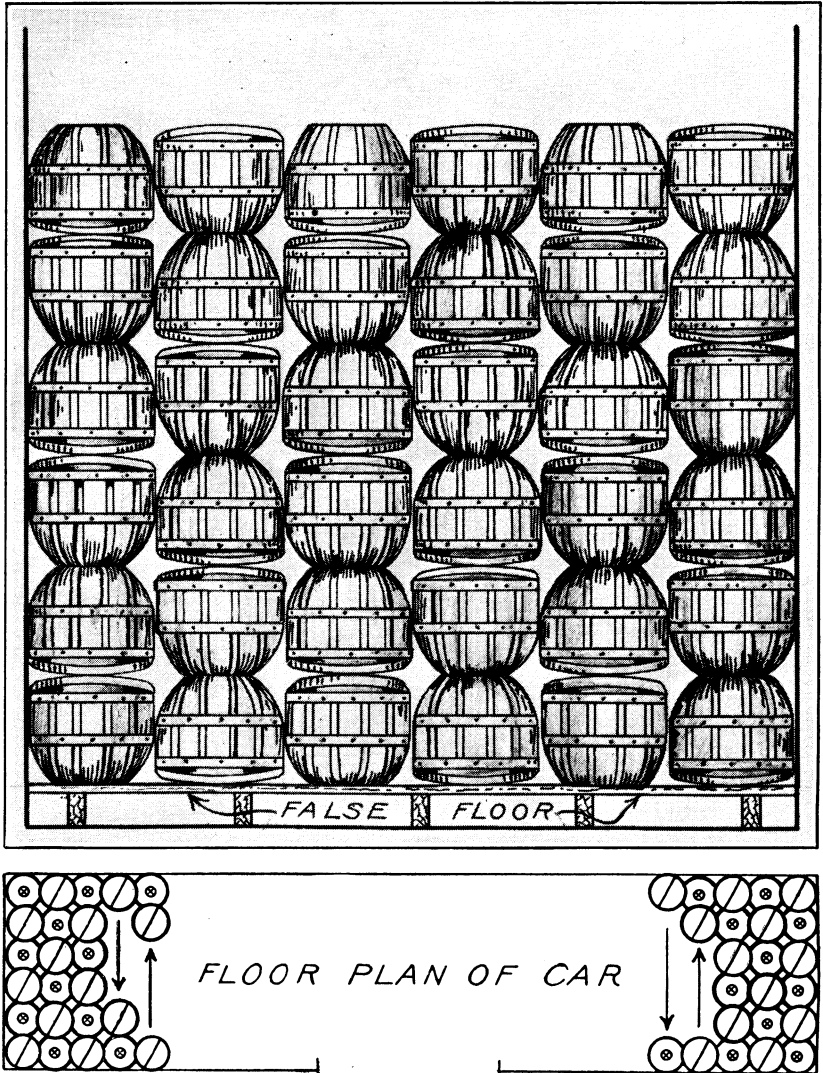


FIG. 5.—Baskets loaded in straight rows.

distant points, where the haul is from one to two thousand miles instead of a few hundred, new conditions were encountered and heavy losses from decay in transit were frequently experienced. These shipments were all in express or freight refrigerator cars, and extra

crushed ice was usually added in each package to prevent wilting. The causes for this deterioration and decay in transit were not understood, and considerable difference of opinion existed among shippers, carriers, and receivers as to the best methods of handling spinach for long hauls.

With these facts in mind, and at the request of various shippers and transportation agents, a study was undertaken by the Bureau of Markets in 1918 to determine the factors involved in the safe transportation of spinach and other winter-vegetable crops. The work was carried on in the New Orleans section of Louisiana and at Austin and other points in Texas during the shipping seasons of 1918 and 1919. The pathological problems involved were studied by the Bureau of Plant Industry.¹

The only decay of importance occurring on spinach in transit is soft rot, a slimy bacterial decay, which is also prevalent on the tops and roots of various other crops in transit and storage. Soft rot develops with exceeding rapidity when temperature and moisture conditions are favorable. It first produces a water-soaked appearance, followed by complete disintegration of the affected tissue, and is often accompanied by a more or less unpleasant odor. In the advanced stages of the rot spinach shrinks in volume and becomes "leaky," often staining the crates with green juice from the destroyed tissue. Soft rot, if well started in transit, is capable, under favorable conditions, of rendering spinach entirely worthless within two or three days after removal from the cars.

Soft rot of spinach is caused by bacteria² which gain entrance at points where the tissue has been bruised or wounded in some way. An example of soft rot starting around the tie band of a bunch of spinach where the leaves and stems have been bruised is shown in figure 6. In order to reduce losses from this decay it is necessary to avoid mechanical injuries to the plants in handling. Soft rot also starts readily on the lower leaves, which are in a state of "physiological old age," and upon leaf spots resulting from fungus attacks originating in the field, such as those caused by mildew³ and anthracnose.⁴

A number of tests made to determine the relation of mechanical injuries to decay showed in every instance that less decay was found in carefully-handled lots, the average being only about one-half that which occurred in comparable lots receiving ordinary commercial handling.

¹ Acknowledgment is made of the valuable work of Dr. J. C. Walker, of that bureau, in identifying the decaying organisms and for other pathological work.

² These bacteria may consist of one of many species belonging to a group of which *Bacillus carotororus*, Jones, is a typical example.

³ *Peronospora effusa*, (Grev.) Rbh.

⁴ *Colletotrichum spinaceae*, Ell. & Halst.

A number of holding and shipping tests were made to determine the influence of washing on the keeping qualities of spinach. The holding tests were conducted in Louisiana during the first season of this investigational work. The experimental lots were packed and held for 10 days under approximate transit conditions on the basis of shipments by freight to northern markets. Those lots which were washed developed an average of 37.3 per cent soft rot, while those that were unwashed developed only 7.7 per cent.

The shipping tests were included in regular car-lot shipments during the second season of the investigational work. These shipments were almost entirely by express, the transit period to Chicago and New York lasting from three to six days. Inspections made at



FIG. 6.—Soft rot starting in bunched spinach where leaves have been bruised by the tie band. The practice of bunching spinach is not recommended.

destination showed that the average percentage of soft rot found in washed spinach on arrival was 5.5, and in unwashed spinach 0.0; three days later the washed spinach showed 24.8 per cent decay and the unwashed 5.7 per cent. The differences in the amounts of decay shown in the lots held and in the lots shipped are due to the differences in the length of periods involved.

These tests show conclusively that, other conditions being equal, washed spinach will decay more quickly than unwashed spinach. The amount of decay that develops depends, of course, to a considerable extent upon the length of time the spinach is in transit. Some of these lots were in transit only three days. The most striking differences between the washed and unwashed lots appeared in cars that were in transit six days and longer.

The advantage gained by shipping unwashed spinach was offset to some extent by increased yellowing and wilting in the spinach above the ice in the unwashed baskets. When part of the ice was put above the spinach on top of the baskets, as described on page 6, this difficulty was entirely overcome and the unwashed lots arrived in excellent condition.

The increase in decay arising from washing spinach is caused in part by the extra handling. Mechanical injuries occur very easily in handling spinach after washing, as the water makes the leaves crisp and brittle. In addition, the excess moisture from washing is favorable to the development of decay, and increased infection doubtless results from the repeated use of the same water when decay organisms are present.

EFFECT OF ICE IN THE PACKAGE ON DECAY.

Holding and shipping tests were made both with and without ice in the package, and much better results were obtained when ice was used, the lots in each separate test being strictly comparable in every other respect. The average percentages of soft rot found in tests in which the packed spinach was held 10 days under conditions approximating those encountered in transit were 31.7 when crushed ice was in package and 55.5 when no ice was in package. Shipping tests by express to New York and Chicago showed that ice in the package reduced the decay greatly. The average percentages of soft rot found in comparable lots after arrival at destination were: Crushed ice in package, 0.0; and no ice in package, 8.9. Three days later the rot in iced packages was 11.9 and the rot in packages without ice 26.8.

Deterioration in transit results from yellowing and wilting as well as from decay. Yellowing occurs when the temperatures in transit become too high.

Several shipping tests were made in which half of the ice was placed in the center of the basket and the remainder on top of the spinach just under the basket cover. This method gave much more satisfactory results than that of placing all the ice in the center of the basket. Unwashed spinach shipped in this manner arrived crisp and fresh on top as well as all through the basket, even when it had been somewhat wilted at the time of packing. When the ice was divided into two layers, it was found that there was more meltage and less ice left at destination, and consequently more refrigeration in transit. In loading cars with baskets iced in this manner, it is necessary to place all the baskets right side up in order to secure the full benefit of the top layer of ice.

Observers accompanied one test trip of two express refrigerator cars from Austin, Tex., to Chicago, Ill. The cars were similar

in construction with bunkers of an open type, and 2-inch floor strips in place of floor racks. One car contained 813 baskets of spinach loaded five high and six wide; the other contained 1,050 baskets loaded six high and six wide, this latter car being loaded to within about 7 inches of the ceiling. One layer of crushed ice, about 14 pounds, was placed in the center of each basket in both cars. By means of electric thermometer equipment, temperatures of the spinach

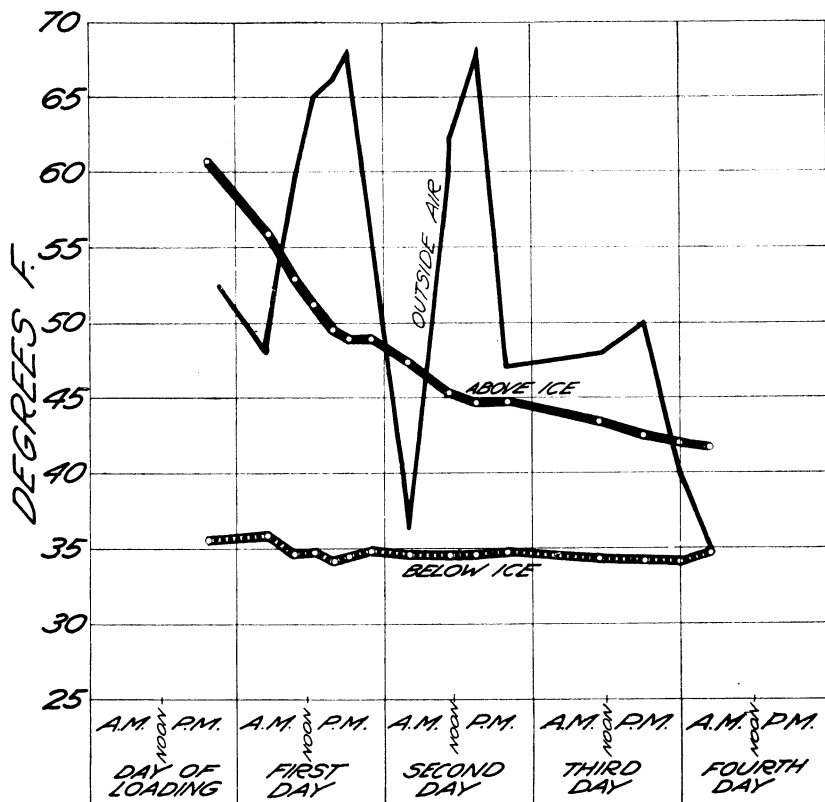


FIG. 7.—Diagram showing the average spinach temperature above and below the ice in the same baskets in the top layers midway between the doors and ice bunker in two express refrigerator cars from the time they were loaded at Austin, Tex., until they were unloaded at Chicago, Ill., March, 1919. All of the baskets in these shipments were iced with about 14 pounds of crushed ice placed near the center of the package. These averages show the need for better distribution of the crushed ice.

at several points inside these cars were determined at frequent intervals during the trip without opening the cars.

Figure 7 illustrates graphically the average temperatures of the spinach in baskets in the top layers of two cars, halfway from the forward bunker to the doorway, both above and below the layer of ice. It is shown that the temperature of the spinach below the ice was uniformly between 34° and 35° for the entire trip, while

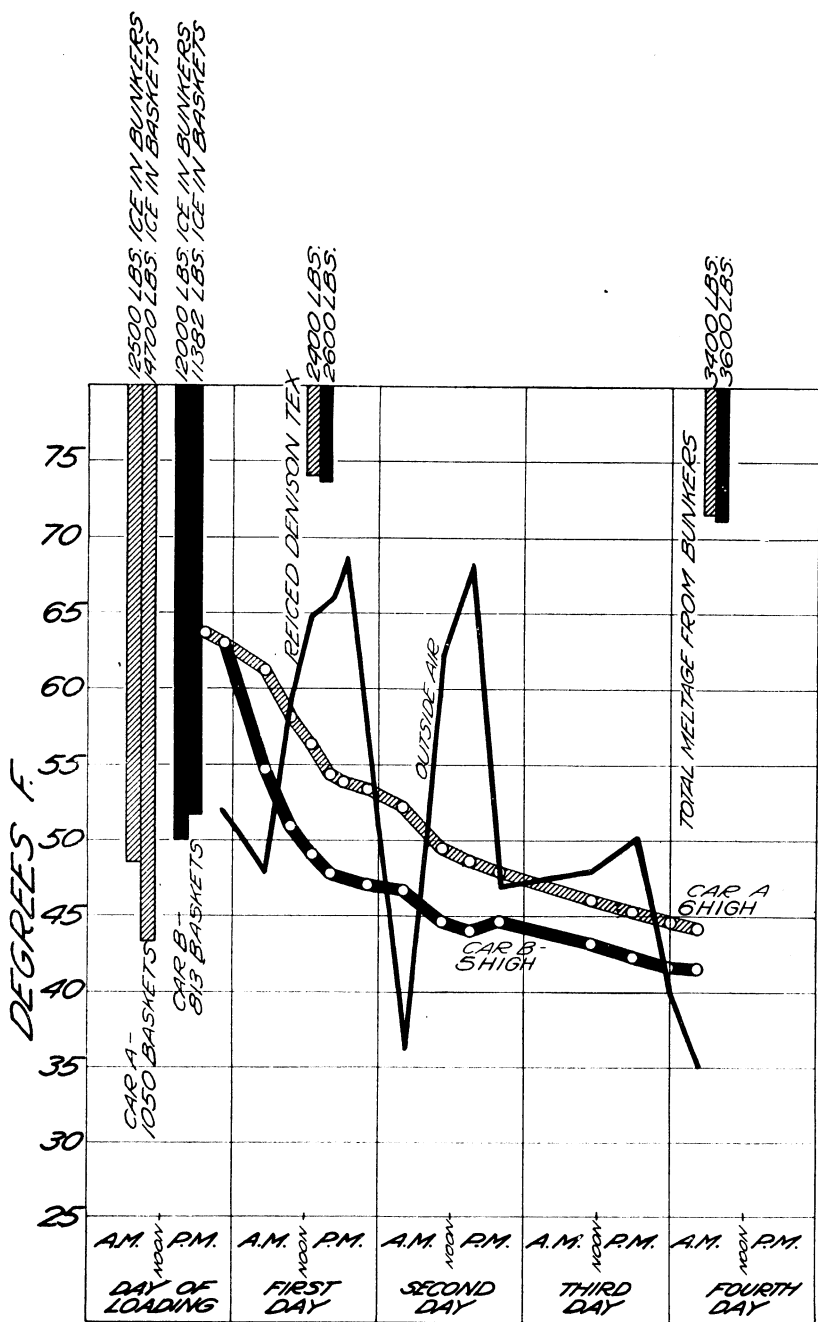


FIG. 8.—Diagram showing the temperatures of the spinach above the ice in the baskets in the top layer, in two express refrigerator cars, in transit from Austin, Tex., to Chicago, Ill., March, 1919, one car being loaded six high and the other five high.

above the ice the temperature of the spinach was about 61° when the cars were loaded, and it was not reduced below 42° during the entire trip. These temperatures are largely equalized when part of the ice is placed at the top of the basket.

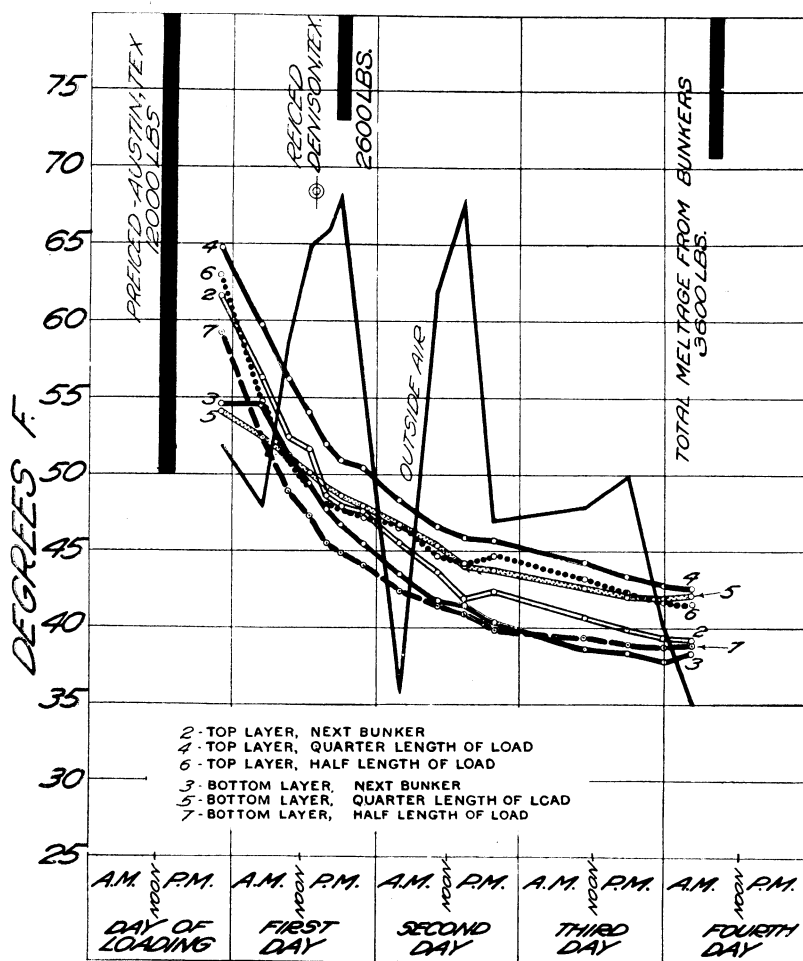


FIG. 9.—Diagram showing actual spinach temperatures in six different parts of an express refrigerator car from the time it was loaded at Austin, Tex., until it was unloaded at Chicago, Ill., March, 1919. The car contained 813 round bushel baskets of spinach, each one containing about 14 pounds of crushed ice in the center of the basket. All temperatures shown were taken in the part of the basket above this layer of ice. The car had 2-inch floor strips in place of floor racks, bunkers of an open type, was loaded solid at the doorway and to within 18 inches of the roof, the baskets being stacked 5 high.

Loading tests included use of floor racks and also the number of baskets and arrangement most advantageous for a load. A comparison of the temperature conditions in the top layers of cars loaded five and six baskets high is presented in figure 8, the data

being secured on the test trip mentioned above. Each basket contained about 14 pounds of crushed ice in a single layer at the center of the basket. This diagram shows the temperatures of the spinach above the layer of ice in baskets midway between the car doors. In the car loaded five high the top layer was cooled 15° in the first 20 hours, while in the car loaded six high the top layer was reduced only 9° in the same length of time. The difference in the temperatures in this position in the two cars for the rest of the trip was 3° to 5° in favor of the five-high load.

The temperatures of the spinach in six different locations in the car loaded five high are illustrated in figure 9. Rapid refrigeration of the spinach occurred throughout the car during the first day of the trip. The top layer cooled at about the same rate as the bottom but held higher temperatures throughout the trip. The temperature of the whole load was uniform when it was loaded, but the first temperatures shown were taken several hours after the car had been closed. The melting ice should cool the leaves sufficiently to keep them fresh and in good condition if the ice is distributed and some of it is placed on top of the spinach just under the basket cover.

